The impact of race and insurance type on the outcome of endovascular abdominal aortic aneurysm (AAA) repair

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Background: **Although mortality and complication rates for abdominal aortic aneurysm (AAA) have declined over the last 20 years, operative complication rates and perioperative mortality are still high, specifically for repair of ruptures. The goal of this study was to determine the influence of insurance type and ethnicity while controlling for the influences of potential confounders on procedure selection and outcome following endovascular AAA repair (EVAR).**

Methods: **Using the Nationwide Inpatient Sample (NIS) database, we identified patients who underwent EVAR repair of ruptured and elective infrarenal AAA, between 1990 and 2003. Insurance type and ethnicity were analyzed against the primary outcome variables of mortality and major complications. The potential confounders of age, gender, operative location, diabetes, and Deyo index of comorbidities, were controlled.**

Results: **Bivariate analyses demonstrated significant differences between insurance types and ethnicity and mortality and complications. Patients who were self pay had adverse outcomes in comparison to Private insurance. Whites encountered less perioperative mortality and postoperative complications than Blacks and Hispanics.**

Conclusions: **After controlling for previously identified associative factors for AAA outcome, ethnicity and insurance type does influence EVAR surgical outcome. Subsequent studies that break down emergent repair vs elective surgery and that longitudinally stratify delay in surgery, or time to admission may be useful. (J Vasc Surg 2008;47: 1172-80.)**

For many years, the gold standard for the treatment of abdominal aortic aneurysm (AAA) was an open surgical repair. As an alternative to conventional surgery, Parodi et al[1] first reported in 1991 the endovascular repair of AAA (EVAR) as a less invasive technique to exclude the aneurysm sac from systemic pressure. The growth of EVAR has been robust within the United States and throughout the world. As the procedure expands to all areas, ethical questions regarding the exposure to all ethnicities and social classes have been raised. Although the availability of this procedure to all has been disputed, the impact of this disease has not. Currently, AAA and aortic dissections are responsible for at least 15,000 deaths annually and in 2000 were the 10th leading cause of death in white men 65 to 74 years of age in the United States.[2] AAAs are most common in the infrarenal region.[3] Risk factors for AAA include tobacco use, hypertension, a family history of AAA, and male sex.[4] Up to 75% of AAA conditions are asymptomatic[3] and surgical intervention is performed to reduce the risk of rupture and death.[4]

Over 40,000 AAA repairs are performed yearly within the United States.[5] Operative treatment of AAA is considered a relatively high risk procedure,[6] with mortality rates ranging from 2% to 10% for elective repair, and 17% to 67% for repair of ruptures.[7] Although advances in medicine, surgery, and anesthesia over the last 20 years is expected to lead to decreased mortality and complication rates for repair of both ruptured and nonruptured AAA, there is little evidence to support that this indeed is the case.[8] Operative complication rates and perioperative mortality remain constant, particularly for repair of ruptures.[6-8]

Past studies have identified that mortality and complication rates are more prevalent in populations that include advancing age,[8,9] geographic (rural vs urban, teaching vs nonteaching) operative locations,[10,11] male gender,[9] and with comorbidities including diabetes.[8,12] However, it is our assessment that these studies have inadequately investigated insurance type and ethnicity or have failed to control for covariates that could influence these factors. Subsequently, there were two primary purposes to this study. First, we investigated whether minority status is associated with a greater number of complications after EVAR. Second, we investigated if insurance type affects complication rates after endovascular repair of AAA. Of particular interest was the investigation of influence of insurance type and ethnicity while controlling for the potential confounders of advancing age,[8,9] geographic operative location,[10,12,13] male gender,[9] and with comorbidities including diabe-

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Table I. Univariate analysis for race including frequency and mean/medians for patients receiving EVAR surgery

Variable	*White*	*Black*	*Hispanic*	*Other*	*P value*
Gender					
Male	7145	200	184	270	$P < .01$
Female	1221	87	34	28	
Surgery type					$P < .01$
Emergency	341	38	14	13	
Urgent	545	21	6	14	
Elective	6592	200	136	158	
Trauma	0	0	1	0	
Other	1	0	0	0	
Household income					$P < .01$
$1-35,999	2367	146	73	50	
$36,000-44,999	2664	65	71	104	
$45,000+	3164	73	65	139	
Hospital region					$P < .01$
Northeast	2448	77	57	97	
Midwest	1293	33	6	21	
South	3425	145	80	61	
West	1200	32	75	119	
Hospital bed size					$P < .01$
Small	533	12	13	13	
Medium	1383	47	23	60	
Large	6450	228	182	225	
Payer source					$P < .01$
Medicare	6800	227	169	231	
Medicaid	76	8	10	10	
Private/HMO	1383	48	31	50	
Self pay	30	1	7	4	
No charge	5	1	0	0	
Other	72	2	1	3	
Deyo classification					$P = .005$
0	4807	177	133	176	
1	2612	74	59	84	
>1	947	36	26	38	

EVAR, Endovascular aneurysm repair.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.

tes.[8,12] Findings may assist in recognizing potential barriers to recovery in selective races and patients with specific insurance plans.

METHODS AND MATERIALS

Data source. The Nationwide Inpatient Sample (NIS) database is part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ). The NIS is a cross-sectional database that includes approximately 20% of all nonfederal hospital discharges in the United States and is stratified by geographic region, urban or rural location, teaching status, ownership, and hospital size.[14] The NIS provides a representative sampling of a number of states and hospitals whose hospital discharges were variably represented over the study period. Within the NIS, each hospitalization is recorded as an independent event. The database records patient demographic information, patient medical diagnoses by diagnostic related groups (DRG), procedure information by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code's primary and secondary diagnoses, length of stay, financial information, and admission and discharge information. The NIS database may be purchased through the Healthcare Cost and Utilization Project, a division of the Federal-State-Industry partnership (sponsored by the Agency for Healthcare Research and Quality), available at http://www.hcup-us.ahrq.gov/home.jsp. We utilized this database to observe complications in patients who received EVAR of infrarenal abdominal aortic aneurysm (AAA) surgery between 1990 and 2003.

Data selection. All adult patients diagnosed with an abdominal aortic aneurysm, abdominal aneurysm without rupture, or an abdominal aneurysm with a rupture were eligible if they received endovascular implantation of a graft in the abdominal aorta. Patients with thoracic and thoracoabdominal aneurysms were excluded from analysis. Similarly, patients who received excisions of abdominal vessels, other excisions of unspecified vessels, repairs of blood vessel with a tissue patch graft, repair of blood vessels with synthetic patch graft, resection of abdominal arteries with anastomosis or aorta-renal bypass did not meet eligibility requirements. In addition, because the study focused on the effect of insurance type on complication rates, patients with insufficient informa-

Table II. Univariate analysis for insurance including frequency and mean/medians for patients receiving EVAR surgery

Variable	*Medicare*	*Medicaid*	*Private*	*Self pay*	*No charge*	*Other*	*P value*
Gender							
Male	6237	80	1,373	35	4	70	$P < .01$
Female	1190	247	139	7	2	8	
Surgery type							
Emergency	309	10	78	4	1	4	$P < .01$
Urgent	468	6	100	3	1	8	
Elective	5759	68	1167	32	4	56	
Trauma	1	0	0	0	0	0	
Other	0	0	1	0	0	0	
Household income							
$1-35,999	2195	42	356	13	2	28	$P < .01$
$36,000-44,999	2341	36	489	14	2	22	
$45,000+	2750	23	628	11	2	27	
Hospital region							
Northeast	2131	23	496	12	3	14	$P < .01$
Midwest	1099	23	215	2	0	14	
South	3047	34	569	22	3	36	
West	1150	24	232	6	0	14	
Hospital bed size							
Small	457	9	90	6	0	9	$P < .01$
Medium	1233	16	243	10	2	9	
Large	5737	79	1179	26	4	60	
Race							
White	6800	76	1383	30	5	72	$P < .01$
Black	227	8	48	1	1	2	
Hispanic	169	10	31	7	0	1	
Other	231	10	50	4	0	3	
Deyo classification							
0	4807	49	960	19	2	41	$P < .01$
1	2612	45	409	19	4	22	
>1	947	10	143	4	0	15	

EVAR, Endovascular aneurysm repair.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.

tion, including missing values regarding insurance, were excluded from the analyses.

Outcome variables evaluated were mortality, length of stay, and postoperative complications including pulmonary embolism, thrombophlebitis, infection, transfusion, cardiac complications, postoperative or anaphylactic shock, hypertension, cognitive deficits, decubitus ulcers, pulmonary insufficiency, renal insufficiency, and discharge strata, divided into routine and nonroutine discharge (nonroutine discharge was associated with transfer to skilled nursing care, intermediate care facility, home health, against medical advice, or death). Our predictive variables included insurance status and race.

Additional variables were collected to describe the sample demographics and for control of in this study.[8-10,12,13] We collected the variables of age, geographic operative location, gender, household income by zip code, hospital bed size, and Deyo classification. Deyo classification was used as the comorbidity index and involves a revision of the Charlson index and appropriate use of ICD-9 coding. Classifications were logarithmically transformed into three groups (0, 1, and >1) with each higher number representing greater incidences of morbidity.

Data analysis. All statistical analyses were performed using Stata version 8.0 for Linux (Stata Corporation, College Station, Tex). Descriptive statistics outlined the variables used within the study. A Pearson χ^2 was used to measure differences between the insurances and races among multiple outcome variables, whereas a Fischer exact was used during the assessment of complications that involved smaller frequencies. Because the variable of length of stay lacked a normal distribution, a Kruskal-Wallis was used to analyze differences in race and insurance.

Lastly, a logistic regression or as needed, a log-linear regression model was used to determine odds ratios for the dichotomous variables for each of the outcome variables. In each regression model, we controlled for the potentially confounding variables of age, gender, hospital location, hospital region, comorbidity status and race when insurance was calculated and insurance when race was calculated. For all comparisons, statistical significance was assigned at the $P \leq .05$ level.

RESULTS

A total of 9169 patients, with an average age of just over 71 years (SD 8.1 years) were included in the analysis. As indicated in Table I, the majority of subjects in all races were male and most of the procedures were elective. The sample was comprised primarily of Whites (91.24%) with

Table III. Bivariate analysis involving Pearson χ^2 and Fischer exact analyses involving race classifications for patients receiving EVAR surgery (Percentage reflects percentage of individuals with corresponding reference whereas parentheses involve the total number of subjects with the reference)

	Race				
Outcomes	*White*	*Black*	*Hispanic*	*Other*	*P value*[a]
Died	69 (0.8%)	6 (2.1%)	0 (0)%	75 (0.8%)	.019
Nonroutine discharge	1,227(14.8%)	51(18.1%)	25(11.5%)	39(13.1%)	.163
CNS complications	21(0.3%)	0(0%)	2(0.9%)	1(0.3%)	.217
Persistent fistula	1(0%)	0(0%)	0(0%)	0(0%)	.992
Respiratory complications	295(3.5%)	13(4.5)	12(5.5%)	10(3.4)	.365
Pneumonia	64(0.8%)	2(0.7%)	2(0.9%)	1(0.3%)	.849
Myocardial infarction	192(2.3%)	5(1.7%)	9(4.1%)	9(3%)	.244
Perivascular complications	31(0.4%)	1(0.3%)	1(0.5%)	0(0%)	.762
Nonperivascular complications	13(0.2%)	0(0%)	1(0.5%)	0(0%)	.525
Acute vascular insufficiency	18(0.2%)	2(0.7%)	0(0%)	0(0%)	.245
Hypertension, postop complications	11(0.1%)	1(0.3%)	0(0%)	2(0.7%)	.088
Hematoma	514(6.1%)	34(11.8%)	13(6%)	24(8.1%)	.001
Serum reaction	5(0.1%)	1(0.3%)	0(0%)	0(0%)	.273
Transfusion	764(9.1%)	51(17.8%)	25(11.8%)	33(11.1%)	<.01
Complication during procedure	59(0.7%)	2(0.7%)	1(0.5%)	2(0.7%)	.979
Complication operative wound	11(0.1%)	0(0%)	0(0%)	0(0%)	.787
Infection	31(0.4%)	1(0.3%)	0(0%)	1(0.3%)	.845
SIRS	27(0.3%)	1(0.3%)	0(0%)	1(0.3%)	.870
Delirium	22(0.3%)	1(0.3%)	0(0%)	0(0%)	.692
Renal complications	241(2.9%)	9(3.1%)	5(2.3%)	7(2.3%)	.891
Digestive complications	110(1.3%)	4(1.4%)	3(1.4%)	0(0%)	.261
Implant complications	153(1.8%)	8(2.8%)	5(2.3%)	4(1.3%)	.559
Other complications	124(1.5%)	13(4.5%)	4(1.8%)	4(1.3%)	.001
Decubitus ulcers	9(0.1%)	0(0%)	0(0%)	0(0%)	.834
Malnutrition	19(0.2%)	2(0.7%)	1(0.5%)	1(0.3%)	.402
Colonic resection	10(0.1%)	2(0.7%)	0(0%)	1(0.3%)	.054
Peripheral angioplasty	49(0.6%)	3(1%)	1(0.5%)	2(0.7%)	.782
Thromboembolectomy	24(0.3%)	1(0.3%)	0(0%)	2(0.7%)	.546
Foreign objects left during surgery	0 (0%)	0 (0%)	1 (.5%)	1 (.3%)	< .01
Tracheostomy	7(0.1%)	1(0.3%)	0(0%)	0(0%)	.439
Intubation	120(1.4%)	4(1.4%)	3(1.4%)	4(1.3%)	.999
Coronary angioplasty	10(0.1%)	0(0%)	1(0.5%)	0(0%)	.425
Filter replacement	8(0.1%)	0(0%)	1(0.5%)	0(0%)	.325

EVAR, Endovascular aneurysm repair; *CNS,* central nervous system; *SIRS,* systemic inflammatory response syndrome.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.
[a]χ^2 test.

smaller representations of Blacks, Hispanics, and other race classifications. Significant differences were notable in all demographic characteristics among races including gender, surgery type, household income as indicated by zip code, hospital region of surgery, hospital bed size, payer source, and Deyo index classification. Variations in demographic characteristics were also present in the univariate analysis associated with insurance classifications (Table II). As with the subdivisions into race, significant differences were notable in all demographic characteristics among races including gender, surgery type, household income as indicated by zip code, hospital region of surgery, hospital bed size, payer source, and Deyo index classification.

With the exception of selected variables (transfusion, respiratory, and renal), overall recorded complications for EVAR were markedly few. Bivariate analyses by race (Table III) resulted in few statistically significant differences. Distinction was found between mortality ($P = 0.02$), hematoma ($P < .01$), transfusion ($P < .01$), and other complications ($P < .01$), and in each case, Blacks had more incidences of complications than other races. Only two reported incidences of foreign objects left during surgery were found ($P < .01$), one in "other" and the other in a Hispanic patient.

Bivariate comparison by insurance resulted in a greater number of significant differences (Table IV). There was a wide variation in non-routine discharge ($P < .01$) as patients with Medicare, Medicaid, and other were more inclined to have a nonroutine discharge. Notable differences in myocardial infarction were present as well ($P = .02$) with greater incidences reported in patients with Medicare and other insurances. Hematomas were significantly different ($P < .01$) as were complications during the procedure ($P = .03$), renal complications ($P < .01$), decubitus ulcers ($P = .02$), and reported occurrences of malnutrition ($P < .01$). In most cases, insurance classifications of other were more inclined to have higher reports of complications. Surpris-

Table IV. Bivariate analysis involving Pearson χ2 and Fischer exact analyses involving insurance classifications for patients receiving EVAR surgery (Percentage reflects percentage of individuals with corresponding reference whereas parentheses involve the total number of subjects with the reference)

	Insurance						
Outcomes	*Private*	*Medicare*	*Medicaid*	*Self pay*	*No charge*	*Other*	*P value*
Died	5 (0.3%)	70 (0.9%)	0 (0%)	0 (0%)	0 (0%)	75 (0.8%)	.171
Nonroutine discharge	107(7.1%)	1,199(16.3%)	16(15.7%)	2(4.8%)	0(0%)	18(23.1%)	$P < .01$
CNS complications	0(0%)	24(0.3%)	0(0%)	0(0%)	0(0%)	0(0%)	.342
Persistent fistula	0(0%)	1(0%)	0(0%)	0(0%)	0(0%)	0(0%)	.999
Respiratory complications	43(2.8%)	274(3.7%)	7(6.7%)	2(4.8%)	0(0%)	4(5.1%)	.260
Pneumonia	12(0.8%)	55(0.7%)	0(0%)	1(2.4%)	0(0%)	1(1.3%)	.751
Myocardial infarction	18(1.2%)	193(2.6%)	1(1%)	0(0%)	0(0%)	3(3.8%)	.018
Perivascular complications	2(0.1%)	30(0.4%)	0(0%)	1(2.4%)	0(0%)	0(0%)	.154
Nonperivascular complications	10(0.1%)	0(0%)	4(0.3%)	0(0%)	0(0%)	0(0%)	.882
Acute vascular insufficiency	2(0.1%)	17(0.2%)	1(1%)	0(0%)	0(0%)	0(0%)	.628
Hypertension, postop complications	2(0.1%)	12(0.2%)	0(0%)	0(0%)	0(0%)	0(0%)	.994
Hematoma	61(4.1%)	510(6.9%)	9(8.7%)	2(4.8%)	2(33.3%)	1(1.3%)	$P < .01$
Serum reaction	0(0%)	6(0.1%)	0(0%)	0(0%)	0(0%)	0(0%)	.923
Transfusion	110(7.3%)	743(10%)	9(8.7%)	2(4.8%)	1(16.3%)	8(10.3%)	.029
Complication during procedure	14(0.9%)	48(0.6%)	0(0%)	2(4.8%)	0(0%)	0(0%)	.026
Complication operative wound	2(0.1%)	9(0.1%)	0(0%)	0(0%)	0(0%)	0(0%)	.998
Infection	1(0.1%)	30(0.4%)	1(1%)	0(0%)	0(0%)	1(1.3%)	.212
SIRS	0(0%)	29(0.4%)	0(0%)	0(0%)	0(0%)	0(0%)	.234
Delirium	2(0.1%)	21(0.3%)	0(0%)	0(0%)	0(0%)	0(0%)	.885
Renal complications	22(1.5%)	230(3.1%)	2(1.9%)	3(7.1%)	0(0%)	5(6.4%)	.002
Digestive complications	19(1.3%)	97(1.3%)	0(0%)	1(2.4%)	0(0%)	0(0%)	.716
Implant complications	16(1.1%)	149(2%)	2(1.9%)	2(4.8%)	0(0%)	1(1.3%)	.135
Other complications	24(1.6%)	118(1.6%)	3(2.9%)	0(0%)	0(0%)	0(0%)	.675
Decubitus ulcers	0(0%)	8(0.1%)	0(0%)	0(0%)	0(0%)	1(1.3%)	.025
Malnutrition	2(0.1%)	19(0.3%)	0(0%)	0(0%)	0(0%)	2(2.6%)	.003
Colonic resection	3(0.2%)	10(0.1%)	0(0%)	0(0%)	0(0%)	0(0%)	.983
Peripheral angioplasty	10(0.7%)	44(0.6%)	0(0%)	1(2.4%)	0(0%)	0(0%)	.628
Thromboembolectomy	3(0.2%)	23(0.3%)	0(0%)	1(2.4%)	0(0%)	0(0%)	.198
Foreign body left in after surgery	1512(100%)	7427(100%)	104(100%)	42(100%)	6(100%)	78(100%)	$P < .01$
Tracheostomy	0(0%)	8(0.1%)	0(0%)	0(0%)	0(0%)	0(0%)	.866
Intubation	13(0.9%)	114(1.5%)	1(1%)	0(0%)	1(16.7%)	2(2.6%)	.009
Coronary angioplasty	2(0.1%)	9(1.4%)	0(0%)	0(0%)	0(0%)	0(0%)	.998
Filter replacement	1(0.1%)	7(0.1%)	1(1%)	0(0%)	0(0%)	0(0%)	.146

EVAR, Endovascular aneurysm repair; *CNS,* central nervous system; *SIRS,* systemic inflammatory response syndrome.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.

ingly, higher reports of intubation ($P < .01$) were noted in patients who were not charged for care.

Logistic regression analyses for race while controlling for insurance status, age, gender, hospital location, hospital region, and comorbidity, demonstrated compelling differences (Table V). Using Blacks as the reference variable, Whites were less likely to have a nonroutine discharge, pneumonia, a transfusion, systemic inflammatory response syndrome (SIRS), colonic resection, and peripheral angioplasty but were more likely to die, have a hematoma, serum reaction, other complications, malnutrition, and a coronary angioplasty. Because of smaller numbers, a number of analyses were not possible for selected complications variables for Hispanic and other races. Consequently, the only other significant variable noted outside of the White race calculations was the increased likelihood of other complications for the other race classification.

Table V. Logistic regression for race adjusted for confounders and insurance classifications

Outcomes	*White*	*P value*	*Hispanic*	*P value*	*Other*	*P value*
Odds ratio and confidence interval						
Died	1.10 (1.04,1.17)	.001	2.01 (1.57,2.57)	.	2.01 (1.57,2.57)	.
Nonroutine discharge	0.80 (0.76,0.83)	<.001	1.27 (1.09,1.49)	.69	1.27 (1.09,1.49)	.908
CNS complications	1.04 (0.78,1.38)	.784	0.79 (0.19,3.24)	.	0.79 (0.19,3.24)	.
Persistent fistula	0.79 (0.64,0.96)	.020	1.06 (0.47,2.42)	.	1.06 (0.47,2.42)	.
Respiratory complications	0.85 (0.74,0.99)	.038	1.58 (0.96,2.60)	.438	1.58 (0.96,2.60)	.88
Pneumonia	0.65 (0.62,0.68)	<.001	1.03 (0.84,1.23)	.458	1.03 (0.84,1.23)	.985
Myocardial infarction	1.46 (0.93,2.30)	.101	1.85 (0.43,7.93)	.135	1.85 (0.43,7.93)	.509
Perivascular complications	0.88 (0.71,1.10)	.278	1.15 (0.42,3.15)	.	1.15 (0.42,3.15)	.
Nonperivascular complications	1.04 (0.81,1.34)	.748	1.52 (0.61,3.78)	.	1.52 (0.61,3.78)	.
Acute vascular insufficiency	0.90 (0.71,1.15)	.406	2.62 (1.31,5.25)	.	2.62 (1.31,5.25)	.
Injury vessels of the abdominal region	1.07 (1.00,1.14)	.041	1.69 (1.33,2.14)	.	1.69 (1.33,2.14)	.
Hypertension, postop complications	0.98 (0.91,1.05)	.505	1.68 (1.28,2.20)	.	1.68 (1.28,2.20)	.449
Hematoma	1.19 (1.14,1.25)	<.001	2.05 (1.71,2.45)	.183	2.05 (1.71,2.45)	.105
Serum reaction	1.10 (1.04,1.17)	.001	2.01 (1.57,2.57)	.	2.01 (1.57,2.57)	.
Transfusion	0.80 (0.76,0.83)	< .001	1.27 (1.09,1.49)	.294	1.27 (1.09,1.49)	.278
Complication during procedure	1.04 (0.78,1.38)	.784	0.79 (0.19,3.24)	.	0.79 (0.19,3.24)	.
Complication operative wound	0.79 (0.64,0.96)	.020	1.06 (0.47,2.42)	.	1.06 (0.47,2.42)	.
Infection	0.85 (0.74,0.99)	.038	1.58 (0.96,2.60)	.	1.58 (0.96,2.60)	.812
SIRS	0.65 (0.62,0.68)	<.001	1.03 (0.84,1.23)	.	1.03 (0.84,1.23)	.
Delirium	1.46 (0.93,2.30)	.101	1.85 (0.43,7.93)	.	1.85 (0.43,7.93)	.
Renal complications	0.88 (0.71,1.10)	.278	1.15 (0.42,3.15)	.435	1.15 (0.42,3.15)	.506
Digestive complications	1.04 (0.81,1.34)	.748	1.52 (0.61,3.78)	.994	1.52 (0.61,3.78)	.
Implant complications	0.90 (0.71,1.15)	.406	2.62 (1.31,5.25)	.271	2.62 (1.31,5.25)	.118
Other complications	1.07 (1.00,1.14)	.041	.	.199	1.69 (1.33,2.14)	.046
Decubitus ulcers	0.98 (0.91,1.05)	.505	.	.	1.68 (1.28,2.20)	.
Malnutrition	1.19 (1.14,1.25)	<.001	1.11 (0.09,13.15)	.934.	2.05 (1.71,2.45)	.886
Colonic resection	0.85 (0.74,0.99)	.038	.		1.58 (0.96,2.60)	.764
Peripheral angioplasty	0.65 (0.62,0.68)	<.001	.	.	1.03 (0.84,1.23)	.878
Thromboembolectomy	1.46 (0.93,2.30)	.101	.	.	1.85 (0.43,7.93)	
Amputation	0.88 (0.71,1.10)	.278	.	.	1.15 (0.42,3.15)	
Tracheostomy	1.04 (0.81,1.34)	.748	.	.	1.52 (0.61,3.78)	.
Intubation	0.90 (0.71,1.15)	.406	1.05 (0.18,5.96)	.955.	2.62 (1.31,5.25)	.775.
Coronary angioplasty	1.07 (1.00,1.14)	.041	.		1.69 (1.33,2.14)	
Filter replacement	0.98 (0.91,1.05)	.505	.	.	1.68 (1.28,2.20)	.

Black is the reference category.
In many of the calculations, the numbers were too small. *P* values and odds ratios were left blank.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.

Logistic regression analyses for insurance (private pay was the reference variable) while controlling for race, age, gender, hospital location, hospital region, and comorbidity, exhibited fewer significant findings (Table VI). Patients with Medicare and other insurance not defined were more likely to have a nonroutine discharge, whereas patients with other insurance not defined were more likely to have a heart attack perioperatively. Patients who were not charged for care were much more likely to have a hematoma, while self pay and other insurances were more likely to have renal complications. Self pay patients were more inclined to have a thromboembolectomy, and patients who were not charged were more likely to by intubated.

DISCUSSION

This study determined that after controlling for age, rural vs urban operative locations, gender, and comorbidities including diabetes, ethnicity, and insurance type does

Table VI. Logistic regression for insurance status adjusted for confounders and race

Outcomes	*Medicare*	*P value*	*Medicaid*	*P value*
Odds ratio and confidence interval				
Died	1.43 (0.48, 4.22)	.517	.	.
Nonroutine discharge	1.33 (1.04, 1.70)	.023	2.00 (1.00, 4.03)	.053
CNS complications	.	.	.	.
Persistent fistula	.	.	.	.
Respiratory complications	1.22 (0.81, 1.84)	.329	1.54 (0.52, 4.52)	.435
Pneumonia	0.88 (0.39, 1.97)	.751	.	.
Myocardial infarction	1.51 (0.83, 2.73)	.177	.	.
Perivascular complications	1.36 (0.29, 6.35)	.696	.	.
Nonperivascular complications	0.48 (0.12, 2.04)	.325	.	.
Acute vascular insufficiency	2.26 (0.43, 11.79)	.335		
Injury vessels of the abdominal region	.	.	.	.
Hypertension, postop complications	1.79 (0.19,16.68)	.61	.	.
Hematoma	1.13 (0.81, 1.59)	.464	1.25 (0.47, 3.34)	.66
Serum reaction	.	.	.	.
Transfusion	0.87 (0.67, 1.13)	.297	1.09 (0.47, 2.55)	.839
Complication during procedure	0.51 (0.22, 1.19)	.119	.	.
Complication operative wound	3.61 (0.33, 39.33)	.292	.	.
Infection	.	.	.	.
SIRS	.	.	.	.
Delirium	2.52 (0.30, 21.33)	.396	.	.
Renal complications	1.14 (0.69, 1.87)	.612	.	.
Digestive complications	1.26 (0.66, 2.41)	.477	.	.
Implant complications	1.34 (0.70, 2.54)	.376	2.09 (0.45, 9.65)	.346
Other complications	0.76 (0.44, 1.29)	.304	1.93 (0.55,6.78)	.303
Decubitus ulcers	.	.	.	.
Malnutrition	.	.	.	.
Colonic resection	0.30 (0.07, 1.34)	.116	.	.
Peripheral angioplasty	0.52 (0.23, 1.18)	.117	.	.
Thromboembolectomy	2.02 (0.42, 9.77)	.38	.	.
Amputation				
Tracheostomy	.	.	.	.
Intubation	1.73 (0.84, 3.58)	.138	.	.
Coronary angioplasty				
Filter replacement	1.43 (0.14, 14.90)	.765	11.69 (0.66, 208. 17)	.094

Private is the reference category.
In many of the calculations, the numbers were too small. *P* values and odds ratios were left blank.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.

influence selected outcome variables for endovascular repair of AAA. Of particular importance, is the finding that insurances such as Medicaid, Medicare, and others are more likely to encounter perioperative mortality and selected complications during surgery than private insurance. Furthermore, non-Whites, specifically Blacks, experience greater mortality and complications than Whites even after controlling for selected variables.

We elected to combine repair of ruptured and nonruptured AAA in the analysis with full recognition that elective repair is associated with significantly lower mortality rates,[15] a finding that has declined continuously over the last several years.[16,17] In our analysis, we focused on endovascular repair with ruptured and nonruptured AAA. EVAR has also been associated with significant short-term reduction in complication rates compared with open repair, which have decreased incidences of cardiac, pulmonary, renal, wound-related, and bleeding complications.[18] Although high risk subjects are often denied an open repair,[5,19] adjustments using a propensity analysis suggest that EVAR is associated with decreased mortality.[18]

Past work has identified that Hispanics and Blacks receive inadequate screening or delayed referral for surgery.[18,20,21] In addition, selective minorities may have diminished access to high quality providers of healthcare.[11,22] Although the exact reason inadequate screening, delayed referral, or diminished access to high quality providers for minorities is unknown,[23] reasons may include complex socioeconomic, culture, and language barriers[21,23] that are multifactorial. Our findings demonstrate that Blacks are more likely to experience death and other postoperative complications, including hematoma formation than compared with Whites. Although not statistically significant, Hispanics were more likely to experience postoperative complications as well when compared with their White counterparts.

Currently, the uninsured patients in the United States are more likely to receive repair of AAA after rupture[9] as well as more likely to experience operative mortality in

Table VI. Logistic regression for insurance status adjusted for confounders and race

Self pay	*P value*	*No charge*	*P value*	*Other*	*P value*
.	.	.	.	.	.
0.59 (0.13, 2.61)	.483	.	.	4.12 (2.08, 8.18)	< .001
.	.	.	.	.	.
.	.	.	.	.	.
0.79 (0.10, 6.02)	.817	.	.	1.59 (0.46, 5.41)	.461
3.04 (0.36, 25.78)	.308	.	.	1.93 (0.23, 16.10)	.542
.	.	.	.	4.27 (1.15, 15.86)	.03
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
1.46 (0.33, 6.50)	.617	17.05 (2.90, 100.32)	0.002	0.39 (0.05, 2.89)	.356
.	.	.	.	.	.
0.54 (0.12, 2.36)	.411	2.36 (0.26, 20.97)	0.442	1.63 (0.69, 3.81)	.262
6.30 (0.73, 54.51)	.94	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
5.83 (1.57, 21.63)	.008	.	.	5.05 (1.76, 14.53)	.003
2.43 (0.30, 19.49)	.402	.	.	.	.
3.12 (0.38, 25.78)	.292	.	.	1.55 (0.19, 12.24)	.68
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
15.05 (1.10, 205.12)	.042	.	.	.	.
		.	.	.	.
.	.	.	.	.	.
.	.	23.04 (2.18, 243.91)	0.009	4.59 (0.95, 22.23)	.058
.	.	.	.	.	.

Private is the reference category.
In many of the calculations, the numbers were too small. *P* values and odds ratios were left blank.
Fisher exact tests were used in analyses where cell block values were ≤ 5. χ^2 tests were used in all other analyses.

elective or ruptured AAA.[9] Our findings indicate that subjects with Medicaid or "other" insurances were more likely to experience postoperative complications, complications that have historically been associated with longer length of stays, re-admissions, and greater hospital expenses.[24] Insurance type may be associated with delayed care or restricted care as Medicaid recipients are less likely to be placed on a transplant list than other insurances[25] and health maintenance organization (HMO) participants are less likely to receive newer medical technologies compared with fee for service patients.[26] Universal healthcare systems are not immune to disparities as individuals with higher socioeconomic statuses are more likely to receive selected cardiac services than lower socioeconomic statuses despite identical insurance plans.[27] Explanations may include more sophisticated skill sets in individuals with better insurance plans and the ability to negotiation and pursue proper healthcare treatment options.[28]

High vs low volume hospitals has been suggested as a possible reason for higher complications and mortality rates.[6,10,13,24] Blacks and Hispanics are less likely to be treated at a high volume hospital,[10] and Blacks, Asians, and Hispanics are all more likely to receive AAA at low volume facilities.[10,11] Blacks have demonstrated higher risk adjusted mortality associated with the differences in high vs low volume settings[11] and all subjects experienced higher complication rates when demographic data, comorbid conditions, and other factors were controlled.[24] We attempted to control for this possibility, by using urban, rural, and teaching facility status as a confounding variable within the study. However, travel for surgical care was not a factor we could control, which may have impacted findings.

Distance required for travel for surgical care may also influence the selection of the facility. Recent information has shown that those who access care outside their regional hospital do so to access more sophisticated services, services not rendered at the local facility, or if the hospital offered services similar to those at a teaching hospital.[29] These services were commonly associated with cardiovascular care, particularly surgical care.[30] In addition, patients with higher levels of comorbidity are more inclined to travel further distances for what they interpret is sophisticated care.[29]

Limitations. This study has two major limitations. First, although we attempted to control for high and low volume surgical facilities by using geographic location and region, there is still the possibility that volume is independent from these variables. Second, the study involves 9169 individuals with AAA repair. Statistically significant differences are easier to achieve with large sample sizes yet clinically significant differences require careful observation by the reader. Some findings express high likelihood of clinically important differences whereas others may demonstrate less magnitude in actual practice. We also encountered lower than expected numbers of subject with diabetes, even after careful re-attention to the coding process of the study. These numbers may underestimate the influence of diabetes as a covariate to this study.

CONCLUSIONS

After controlling for previously identified associative factors for endovascular AAA repair outcome, ethnicity and insurance type does affect surgical outcome. Subsequent studies that break down repair vs elective surgery and that longitudinally stratify delay in surgery, or time to admission may be useful.

AUTHOR CONTRIBUTIONS

Conception and design: AL, CC, ST, DM, CS
Analysis and interpretation: CC, CS, ST
Data collection: CC, ST
Writing the article: AL, CC, ST, DM, CS
Critical revision of the article: AL, CC, ST, DM, CS
Final approval of the article: AL, CC, ST, DM, CS
Statistical analysis: CC, ST
Obtained funding: CS, DM
Overall responsibility: CS[21]

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